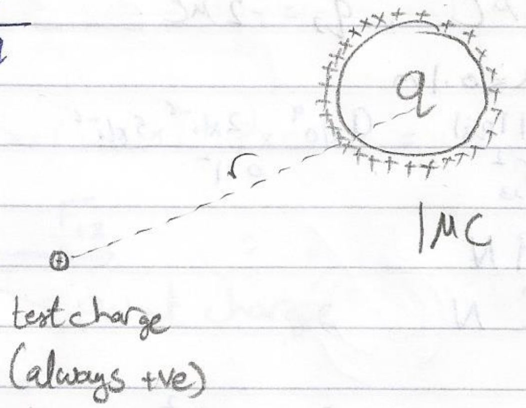
Electric fields

Electric field intensity $\bar{E} = \frac{\bar{F}}{q}$

unit : N/C

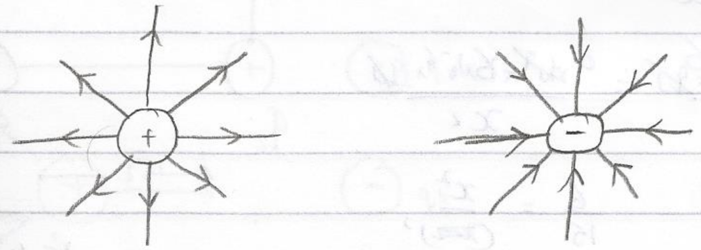


Field of a point charge

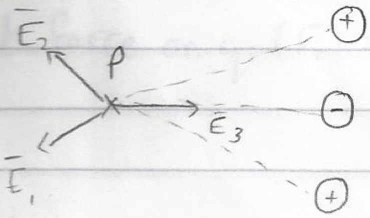
$F = k \frac{|q||q_0|}{r^2} \div q_0$ $\qquad \frac{F}{q_0} = k \frac{|q|}{r^2}$

$\therefore \boxed{\bar{E} = k \frac{|q|}{r^2}}$

* The field of a +ve charge's direction is away from the charge
* The field of a -ve charge's direction is towards the charge

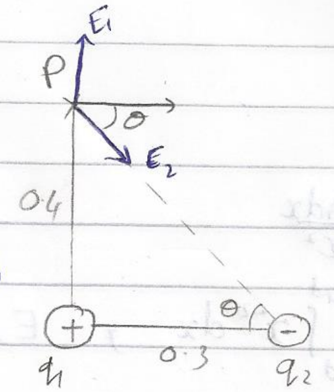


For N-point charges



$\bar{E}p = \bar{E}_1 + \bar{E}_2 + \bar{E}_3$

$q_1 = 7\mu C$, $q_2 = -5\mu c$ Find E at p



$\bar{E} = \bar{E}_1 + \bar{E}_2$

$E_1 = \frac{k|q|}{r^2} = 9\times10^9 \times \frac{7\times10^{-6}}{0.4^2} = 3.94\times10^5 \frac{N}{C} = 3.94\times10^5 \hat{j}$

$E_2 = \frac{k|q|}{r^2} = 9\times10^9 \times \frac{5\times10^{-6}}{0.5^2} = 1.8\times10^5 \frac{N}{C}$

$E_{2x} = 1.8\times10^5 \cos\theta = 1.8\times10^5 \times \frac{0.3}{0.5} = 1.08\times10^5 \frac{N}{C} = 1.08\times10^5 \hat{i}$

$E_{2y} = 1.8\times10^5 \times -\sin\theta = 1.8\times10^5 \times \frac{-0.4}{0.5} = -1.44\times10^5 \frac{N}{C} = -1.44\times10^5 \hat{j}$

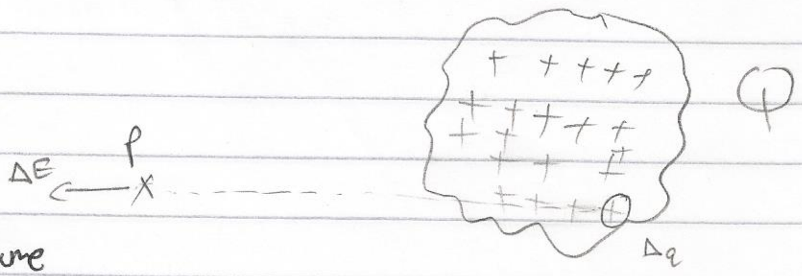
$\bar{E} = 3.94\times10^5 \hat{j} + 1.08\times10^5 \hat{i} - 1.44\times10^5 \hat{j} = 1.08\times10^5 \hat{i} + 2.5\times10^5 \hat{j}$ N/C

$|E| = \sqrt{(1.08\times10^5)^2 + (2.5\times10^5)^2} = 2.72\times10^5$ N/C , $\theta = 66°$

field of a continuous charge

$\sum \Delta E = k \sum \frac{\Delta q}{r^2}$

$E = \int dE = k \int \frac{dq}{r^2}$



linear surface volume

$dq = \lambda dt = \sigma dt = \rho dt$

λ. lamda
σ sigma
ρ rho
} density charge

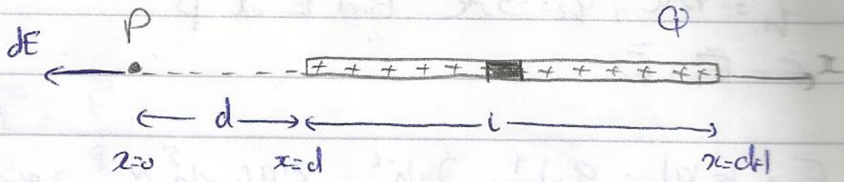
for uniform charges

$\lambda = \frac{Q}{L} \longrightarrow C/m$

$\sigma = \frac{Q}{A} \longrightarrow C/m^2$

$\rho = \frac{Q}{V} \longrightarrow C/m^3$

Example



$dE = k\frac{\lambda dx}{x^2}$

$E = k\lambda\int_d^{L+d} x^{-2}\,dx$, $E = k\lambda\left[\frac{-1}{x}\right]_d^{L+d}$

$= -k\lambda\left(\frac{1}{L+d} - \frac{1}{d}\right) = k\frac{\lambda L}{d(L+d)}$, $E = k\frac{Q}{d(L+d)}$